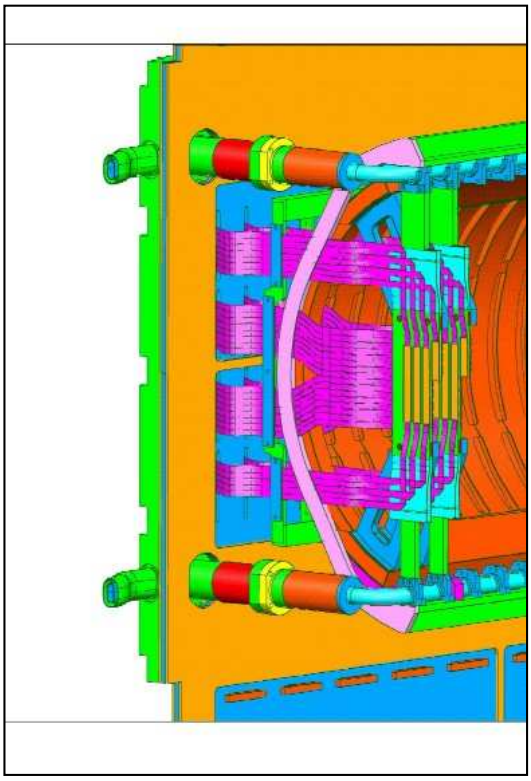
Pixel Detector Cooling System Description (from an edited vacuum system description)

General Description

The BTeV silicon pixel detector contains 30 planar stations of multi-chip modules that reside inside the vacuum of the Tevatron close to the beam. The detector sits within a 1.5 Tesla analysis magnet. The silicon detector contains ~1700 electrical cables and generates a heat load of ~ 3 kW. The pixels are as close as 6 mm from the beam during operation and are retracted to a distance of 20 mm from the nominal beam axis during beam injection. Components in the central portion of the detector are chosen to minimize mass in the active region. The primary pumping for the pixel system is provided by large LN_2 cooled panels. Additional pumping is provided for non-condensable gases. The signal cables connect to a large multi-layer printed circuit board, which provides the vacuum feed-through of the signals outside of the vacuum vessel. The feed-through boards mount to the sides of the vacuum vessel. The pixel stations are cooled by LN_2 supplied in 4 parallel stainless steel cooling tube loops. The stations are thermally connected to the cooling tubes with high thermal conductivity graphite. All cooling line joints are isolated from the Tevatron vacuum.

Cooling Connections

Each of the 30 pixel stations generates 100 W of power in the sensors and readout electronics. To operate properly the sensors need to be cooled to -10° C. The sensors are located in the active region of the detector where mass must be kept to a minimum. To provide leak free operation in vacuum, the cooling connections must be very reliable or avoided completely



To satisfy these requirements a design has been developed to provide cooling by LN_2 supplied in 4 parallel stainless steel tube loops. Heat is transferred to the cooling tubes with thermal conduction connections from the pixel stations. The large temperature gradient between the silicon sensors and the cooling tubes allows minimum material to be used in the thermal conduction connection. The material for this connection is high thermal conductivity graphite. Two different forms of graphite are used. One form is rigid and the other form is flexible. The rigid form has 4X the thermal conductivity of copper at room temperature. The conductivity increases significantly at lower temperatures. The flexible graphite form provides for low force compliance between the cooling tube and the pixel sensor assembly. The pixel sensors are mounted to a .38 mm thick piece of rigid graphite

The LN_2 flow requirements can be met with ½ diameter tubing. The operating pressure will be 45 psig and with an LN_2 boiling temperature of -185° C. The exit quality (mass of vapor/total mass) will be 0.4 and the total flow for all 4 loops will be 200 L/h.

Temperature balancing and control will be accomplished with resistive heaters mounted to the pixel stations.